Microwave Subsystem

Part one, by Adrian Knott, G6KSN*

WITH THE introduction of the latest satellite receivers with 2GHz coverage for reception of Astra 1D and now digital, many older receivers have become available on the surplus market. Most of these are keenly priced, typically between £10 and £20. These receivers can be put to good use as the basis of a composite microwave subsystem carrying 625 line colour TV, data at 19200 baud or more (for use as a full duplex packet radio link) and several hi-fi audio channels simultaneously.

The logical (and probably the easiest) frequency band to use is 3cm, which covers 10-10.15GHz and 10.3-10.5GHz. The reason for this choice is fairly obvious; surplus LNBs covering 10.95 to 11.75GHz are readily available, as are Gunn oscillator modules operating between 10.5 and 10.7GHz. These units can be converted to operate in the 10.3-10.5GHz range with relative ease, and suitable dishes with the correct F/D ratio are available for only a few Pounds. Having said this, there is no reason why the system would not operate in any of the bands above 1.2GHz, so long as a Gunn (or DRO etc) oscillator and suitable LNB are available for the band in question.

Workable signals in the 3cm amateur band are generally classed as 'line of sight', especially when low power and wide bandwidths are employed. Most satellite receivers have an IF passband of around 27MHz, allowing for a good video signal-to-noise ratio, even when the carrier-to-noise ratio is only 10dB or so.

A typical Gunn diode oscillator can produce around 10mW of RF. Not much you might think, but when coupled with a high gain dish at each end of the link and a high sensitivity LNB things are not quite as bad as they may at first seem. A 60cm dish at 10GHz will have around 30dB of gain, enough to boost a meagre 10mW up to 10W erp! The use of wideband FM also means that the received carrier-to-noise ratio need only be of the order of 10dB for an acceptable link. Line of sight paths of 50 to 100km now suddenly start to look feasible with this type of equipment.

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SUBSYSTEM BOARD

A QUICK LOOK at **Fig 1**, the 'baseband' spectrum of a typical composite signal would be in order before a full explanation of the subsystem (block diagram in **Fig 2**) is given. A typical luminance video signal will occupy up to around 5MHz, any less than this and the picture will gradually lose horizontal resolution. The high frequency end of the spectrum is shared by the colour information at around 4.43MHz. This is possible because of the nature of these two signals. The satellite receiver is capable of handling baseband signals up to around 10MHz, (27 - (3.5 x 2) /2) MHz, where 27MHz is the IF passband and 3.5MHz is the peak video deviation. In practice signals above 8.5MHz are seldom used. The point is that the baseband signal can accommodate several subcarriers that occupy the frequency spectrum above the main video signal.

It is customary to use 6.5MHz (around 75kHz deviation) as the main audio subcarrier and this has been implemented in the prototype, although other frequencies may be used as some satellite receivers will not demodulate a 6.5MHz signal without modification.

Secondary narrowband (50kHz maximum) subcarriers at 7.02 and 7.20MHz have also been included to allow some flexibility on the link and have several potential uses such as stereo shack audio, AFSK data, station identification, etc.

An FSK data signal is included at 6MHz and will operate at all baud rates up to 28800 and beyond. The protocol is RS232 (IBM serial compatible), but must use software handshaking since in effect only TXD and RXD lines are present. The G8BPQ 408 packet switch software will work well here, and an explanation of how to configure BPQ will be included in part two of the article. Other software such as 'Hyperterminal' and similar comms programs can also be made to work and will give slightly higher transfer rates for a given baud rate because of the different protocols used. Both the video and audio signals are subjected to pre-emphasis prior to transmission, in order to improve the overall signal-to-noise ratio.

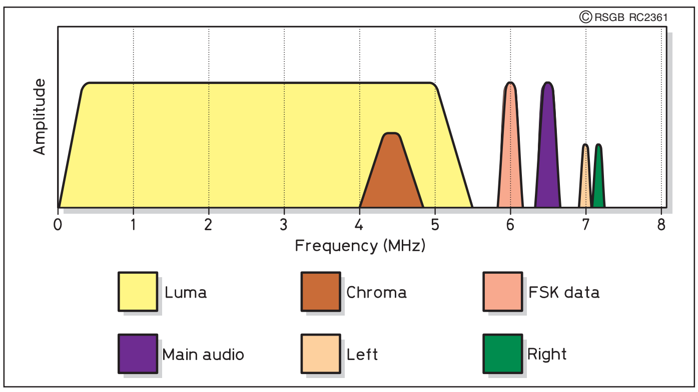

Fig 1: Baseband frequency spectrum of a composite signal.

LNBs

TO RECEIVE the 3cm amateur band it is necessary to move the local oscillator frequency of the LNB from 10.0 (or 9.75GHz) to a lower value. Another possibility would be to lower the lowest frequency receivable on the satellite receiver. In fact there are several possibilities. One is to purchase an LNB ready converted for the job. These generally have the oscillator running at 9.0GHz and thus have full coverage. Another possibility is to use one of the new generation of LNBs with a 9.75GHz local oscillator in addition to an ADX or similar converter which will allow coverage of the top end of the 3cm band.

My experiments with old Marconi 'Blue Cap' LNBs revealed a way of lowering the local oscillator frequency from 10GHz to around 9.3GHz without resorting to anything other than some Evo Stik® and a second 'puck'.

The local oscillator in an LNB has its frequency controlled fairly precisely by a small device akin to a crystal, known as a 'dielectric resonator' or 'puck'. There is no direct electrical connection to the puck, as its proximity to the oscillator circuitry is sufficient to accurately control the frequency. I found that adding a second puck and changing the dielectric constant of the oscillator chamber with glue is sufficient to cause quite a dramatic frequency shift. This may not be the most elegant solution to the problem, but it certainly works!

The front end of the LNB will not quite be tuned to the correct frequency, so sensitivity will be a little down on normal, but unless you have access to a microwave signal generator and spectrum analyser it will have to be tolerated. This method does of course mean that a second puck from a broken LNB is required.

BLUE CAP LNB CONVERSION

ACCESS TO A microwave source (Astra) to determine the effect of the process is important. A suitably located dish set up for Astra in the shack will be found to be very useful. If your shack does not have a south facing window, then you are in trouble.

Firstly, check the LNB's local oscillator frequency by tuning to ZDF. This is the lowest frequency transponder on Astra 1C and is normally the last station that can be tuned-in on an old satellite system (one which utilises an LNB with the local oscillator running at 10.0GHz) when searching from high to low. The satellite receiver should show 963MHz on its display. Make a note of picture quality at this point. It is obviously important that we do not

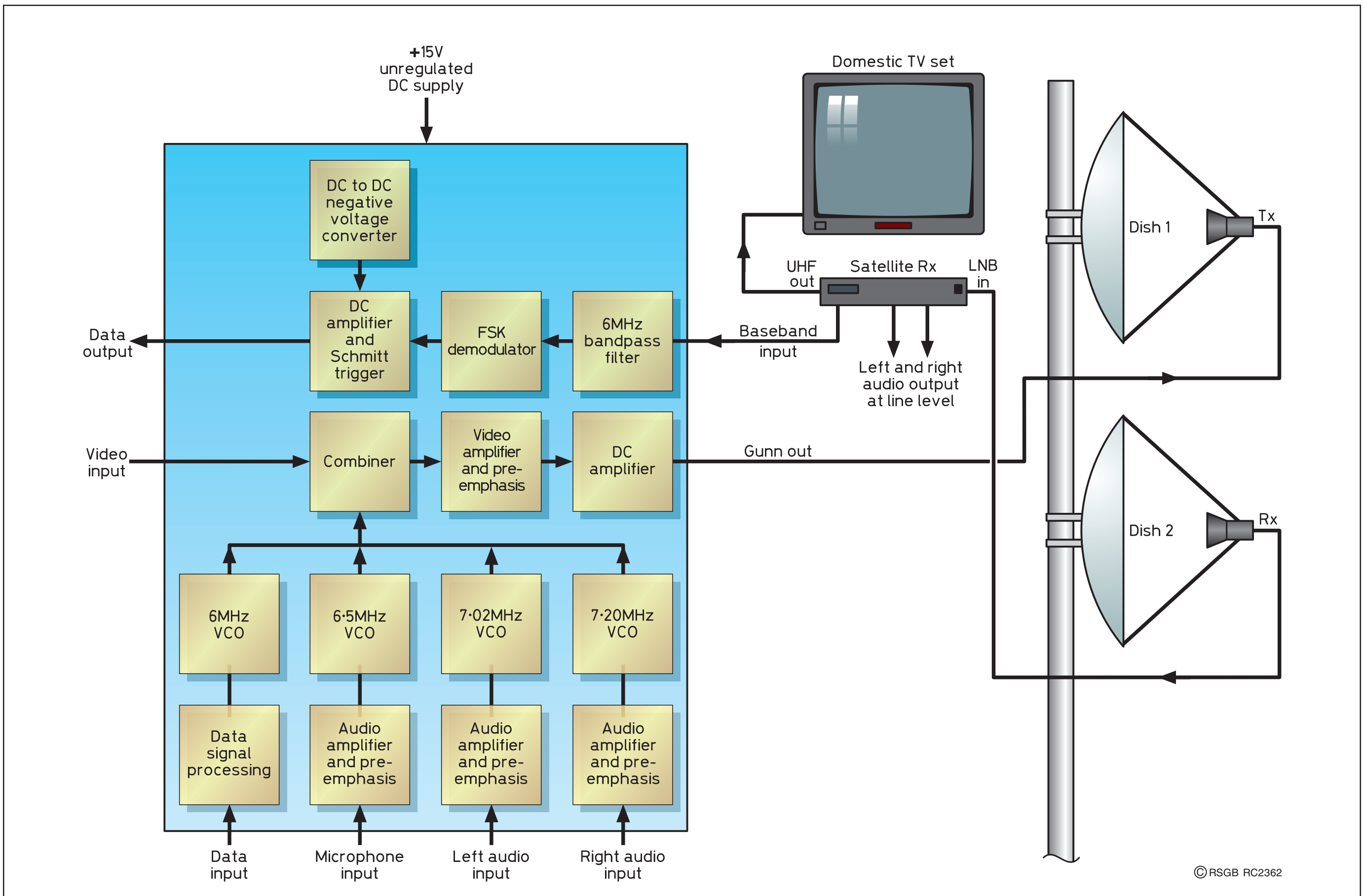

Fig 2: Block diagram of the subsystem.

degrade this too much by our efforts to pull the local oscillator low in frequency. If ZDF is P5 then it should still be so after the modification has taken place.

Drill out the four rivets that hold the back cover of the blue cap LNB in position and remove it. Carefully remove all the Allen screws that hold the aluminium casting in position and store them in a safe place. Glue the second puck in position as shown in **Fig 3** and replace the aluminium casting, but only use two Allen screws to hold it in position temporarily. These Allen screws are very fragile, so only use the minimum force to tighten them. Reassemble the LNB on the dish and check ZDF's new frequency. This should be around 200MHz higher, ie 1163MHz. Tuning the satellite receiver to a lower frequency should reveal Astra 1D at this stage. Undo the adjustment screw on the casting over the oscillator compartment and note that the local oscillator frequency decreases further. Disassemble the LNB again and add a layer of glue within the oscillator compartment, covering both of the pucks and the tuned lines. Allow it to dry for a few minutes and recheck the frequency as before. As the glue dries, the local oscillator frequency will increase slightly. Add several layers of glue over a period of a few hours until the desired effect is achieved, checking the change in frequency each time by monitoring Astra. The frequency stability will be poor until the glue has had a chance harden properly (a day or two). To cover a sufficient part of the 3cm band for full duplex operation, the local oscillator of at least one of the LNBs used on the link must be moved by not less than 600MHz to 9.4GHz.

MAIN BOARD CIRCUIT

REFERRING TO **Fig 4**, IC5 is fed with 15V unregulated, and produces a regulated 12V output to supply the entire circuit. C47, 48 and 49 decouple IC5 and help prevent instability. 1V peak to peak video is fed to R49 and RV8, which together form the required 75Ω termination. A fraction of this video signal is taken from the slider of RV8 and fed through DC blocking capacitor C43 to the base of TR5, which inverts the video signal and also combines the various subcarrier signals which are fed to its emitter through C44. The composite signal thus produced appears on the collector of TR5. TR6 amplifies and once again inverts it. The high frequency gain of this stage is lifted by C46 in the emitter circuit, to pre-emphasise the video. The gain of this stage is substantially flat above 5MHz and so the subcarriers, although amplified, are not pre-emphasised.

The collector of TR6 is DC coupled to the base of TR7, which in conjunction with TR8 forms a Darlington pair. R58 overcomes the internal capacitance of the transistors and helps maintain the HF response. DC negative feedback from the emitter of TR8 is fed back through R60, R86 and RV9 to the base of TR6. The resting DC level at the emitter of TR8 can thus be set by adjusting RV9. R61 in conjunc-

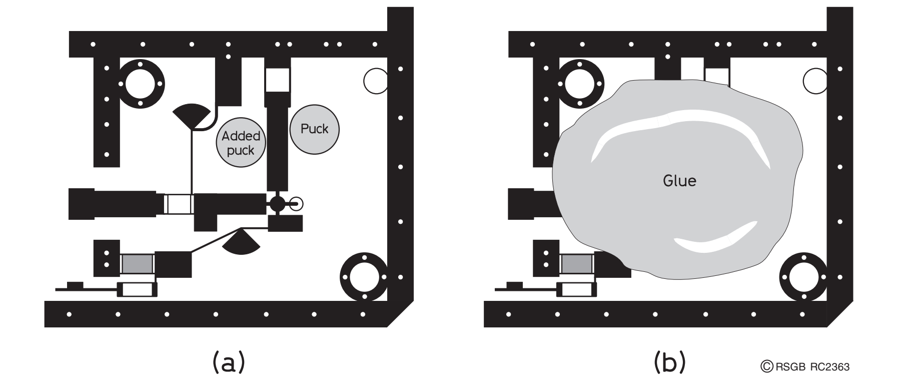

Fig 3: A 'Blue Cap' LNB can be 'pulled' LF using a second puck and Evo Stik®.

tion with the output impedance of TR8 provide a reasonable match to coaxial cable. R61 also acts as a current limiter in the event of a fault ever arising.

The audio subcarrier generators are virtually identical, so only the left 'line' input circuit will be described. Audio at line level feeds to an inverting op-amp, IC1a, through C1, which provides low frequency roll off and DC blocking. The gain of the stage is set by RV1. The op-amp is run from a single-ended supply, so a potential divider consisting of R2 and R6 holds the non-inverting input at half the supply rail and thus provides bias. C2 decouples this supply. The output from IC1a is fed through an equalising network R3, C3, C63, R4 to IC1b, another inverting amplifier. C4 rolls-off the HF response. The amplified, equalised output is fed through a potential divider to lower the DC resting voltage to 3V and then feeds a varicap diode, VD1, through R79. This causes the oscillator based around TR1, L1, C7, C8, C9, C11 etc to become frequency modulated. The centre frequency of oscillation is 7.02MHz for this channel. A fraction of this RF signal is tapped off through R41, RV4 and combined with the other subcarriers through R42.

The data signal which nominally uses ±12V for the two logic levels (note that this input is not TTL compatible) is fed to an inverting comparator which will produce an output of approx +11V for any input less than 5V and approx +1V for any input greater than 7V. This signal is fed to an inverting amplifier whose gain is less than unity and can be adjusted by RV10 to set the deviation to the correct value. C35 and R36 determine the cut-off frequency of the amplifier and form a low pass filter (6dB per octave) to prevent the bandwidth of the resulting FM signal from becoming excessive. TheVCO stage is identical to that of the audio subcarrier oscillator stage described previously. The combined subcarrier output is fed via C72 to a common emitter buffer amplifier based around TR10. The output of TR10 feeds the emitter of TR5 via C44.

Referring to **Fig 5**, the unequalised composite baseband signal from the satellite receiver is fed to the primary of L6 via R62. The secondary of L6 is bought to resonance at 6MHz by C67. The secondary tap feeds CF1, a 6MHz ceramic filter. TR9 and associated components form a common emitter amplifier, the output of which feeds a second ceramc filter, CF2. The resultant filtered FSK data signal is fed to a discriminator, IC6, a TBA120S. L5 is the quadrature coil and demodulated data appears at pin 8. This is amplified by IC7a and the zero crossing point is set by RV11. IC7b forms a Schmitt trigger and an RS232 compatible data signal appears at both the outputs of IC7b and IC7c. R75 acts as a current limiter in the event of a fault, and will also help prevent instability if the IC is required to feed a length of screened cable.

IC8 is a 555 timer, configured as an astable

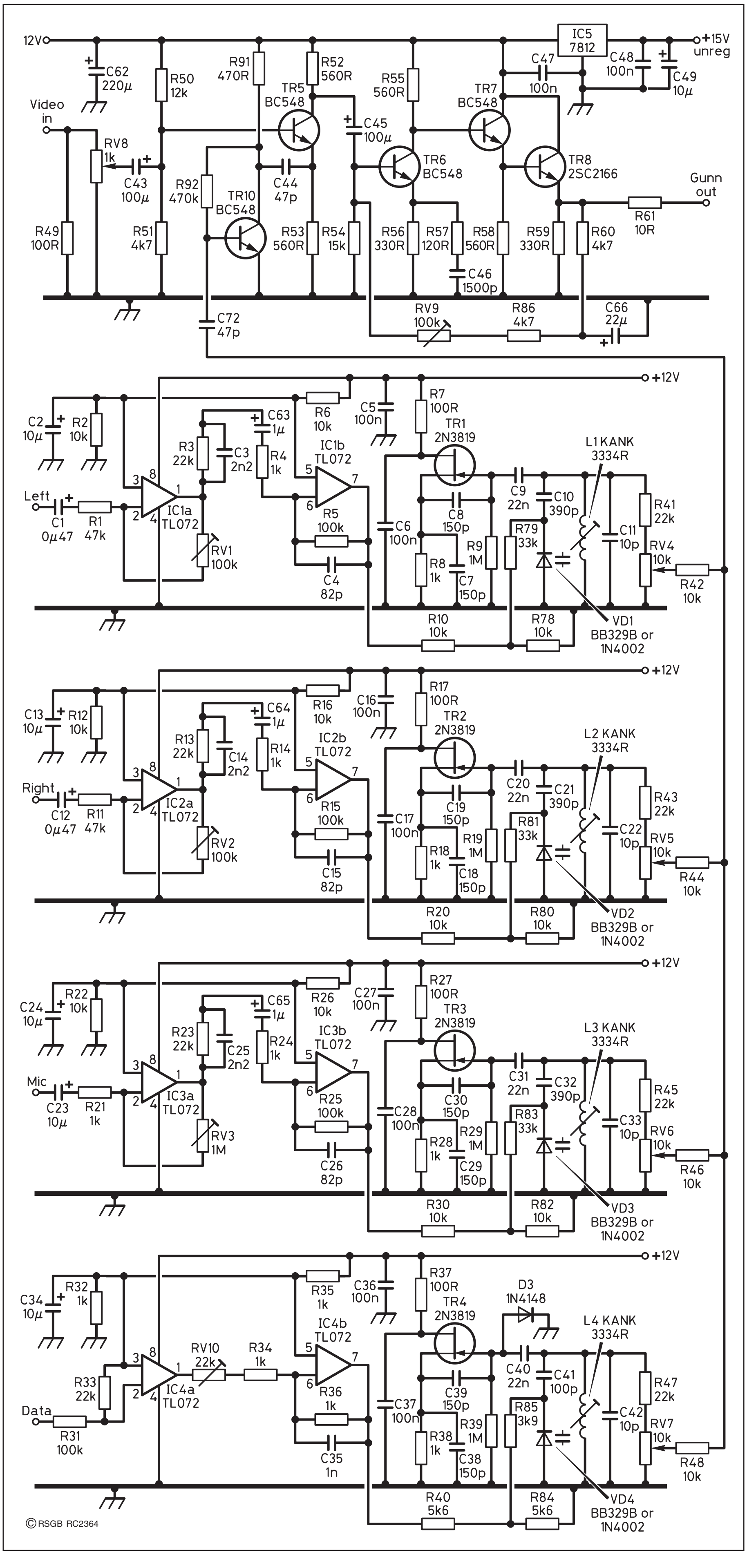

Fig 4: Part of the circuit diagram of the subsystem. Refer to the text for a detailed description.

COMPONENTS

Resistors

R1, 11, 70	47k
R2, 12, 22	10k
R3, 13, 23	22k
R4, 14, 24	1k
R5, 15, 25	100k
R6, 16, 26	10k
R7, 17, 27	100R
R8, 18, 28, 38	1k
R9, 19, 29, 39	1M
R10, 20, 30	10k
R21, 32, 34, 35, 36	1k
R31	100k
R33, 41, 43, 45, 47	22k
R37, 49	100R
R40, 84	5.6k
R42, 44, 46, 48	10k
R50	12k
R51	4.7k
R52, 53	560R
R54	15k
R55, 58	560R
R56, 59, 63, 64	330R
R57	120R
R60, 66, 71, 72	4.7k
R61, 93	10R
R62	82R
R65	270R
R67, 68, 77	22k
R69	56k
R73	1M
R74	1.5k
R75, 91	470R
R76, 86	4.7k
R78, 80, 82	10k
R79, 81, 83	33k
R85	3.9k
R87, 92	470k
R88	330R
R89	1k
R90	100R
RV1, 2, 9, 11	100k
RV3	1M
RV4, 5, 6, 7	10k
RV8	1k
RV10	22k

Capacitors

C1	0.47μF 10V electrolytic
C2	10μF 10V electrolytic
C3, 14, 25	2.2nF polyester
C4, 15, 26	82pF ceramic plate
C5, C6	100nF polyester
C7, C8	150pF ceramic plate
C9, 31	22nF polyester
C10, 32	390pF ceramic plate
C11, 33	10pF ceramic plate
C12	0.47μF 10V electrolytic
C13, 34	10μF 10V electrolytic
C16, 17	100nF polyester
C18, 19	150pF ceramic plate
C20	22nF polyester
C21	390pF ceramic plate
C22	10pF Cceramic plate
C23, 24	10μF 10V electrolytic
C27, 28	100nF polyester
C29, 30	150pF ceramic plate
C35	1nF ceramic disc
C36, 37	100nF polyester
C38, 39	150pF ceramic plate
C40	22nF polyester
C41	100pF ceramic plate
C42	10pF ceramic plate
C43, 45	100μF 16V electrolytic
C44	47pF ceramic plate
C46	1500pF ceramic plate
C47, 48	100nF polyester
C49, 50	10μF 25V electrolytic
C51, 52	22nF ceramic plate
C53	1nF ceramic plate
C54	220pF ceramic plate
C55	100nF polyester
C56	22nF polyester
C57	100μF 25V electrolytic
C58, 61	100nF polyester
C59, 60	220μF 16V electrolytic
C62	220μF 16V electrolytic
C63-65	1μF 16V electrolytic
C66	22μF 16V electrolytic
C67	270pF ceramic plate
C68	10nF polyester
C69	2.2nF polyester
C70, 71	22nF polyester
C72	47pF ceramic plate

Semiconductors

TR1, 2, 3, 4	2N3819
TR5, 6, 7	BC548
TR8	2SC2166
TR9, 10	BC548
IC1, 2, 3, 4	TL072
IC5	7812
IC6	TBA120S
IC7	TL084
IC8	NE555
D1, 2, 3	1N4148
VD1, 2, 3, 4	BB329B or 1N4002
LED1	Red 0.2in
LED2	Green 0.2in

Miscellaneous

L1-L6	Toko KANK3334R
CF1, 2	SFE 6.0MB 6MHz ceramic
PCB	Veropins Case

Sockets for video, audio, data, power input and Gunn supply

Knobs for some functions (but can be preset)

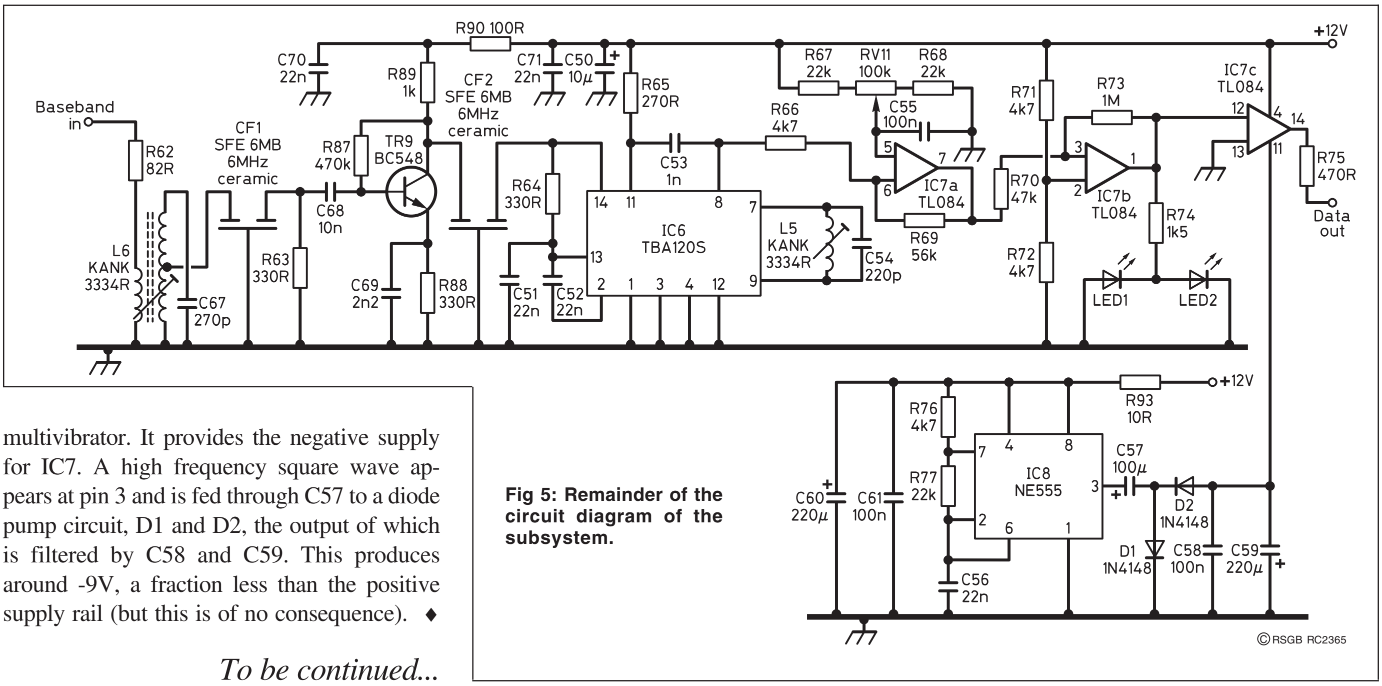

Fig 5: Remainder of the circuit diagram of the subsystem.

multivibrator. It provides the negative supply for IC7. A high frequency square wave appears at pin 3 and is fed through C57 to a diode pump circuit, D1 and D2, the output of which is filtered by C58 and C59. This produces around -9V, a fraction less than the positive supply rail (but this is of no consequence). ♦

To be continued...

Microwave Subsystem

*Final part, by Adrian Knott, G6KSN**

IN PART ONE a description of the system was followed by details of how to convert satellite TV 'Blue Cap' LNBs for use on the 10GHz amateur band. This was followed by the circuit diagram of the subsystem. In part two the PCB is shown (**Fig 6**), plus details of construction and alignment.

CONSTRUCTION

THIS IS QUITE straightforward. None of the components is sensitive to static and no special handling precautions are required. However, it would be a good idea to leave insertion of the semiconductors and inductors until last, as excessive heat can cause problems with both. The inductors have very fine wire attached to the five pins around the base that can be damaged if the pins are forced. Personally, I would begin construction by inserting the Veropins, followed by resistors, capacitors (remembering to check the polarity of electrolytics), filters, inductors, diodes, transistors and finally the ICs, again observing polarity/orientation.

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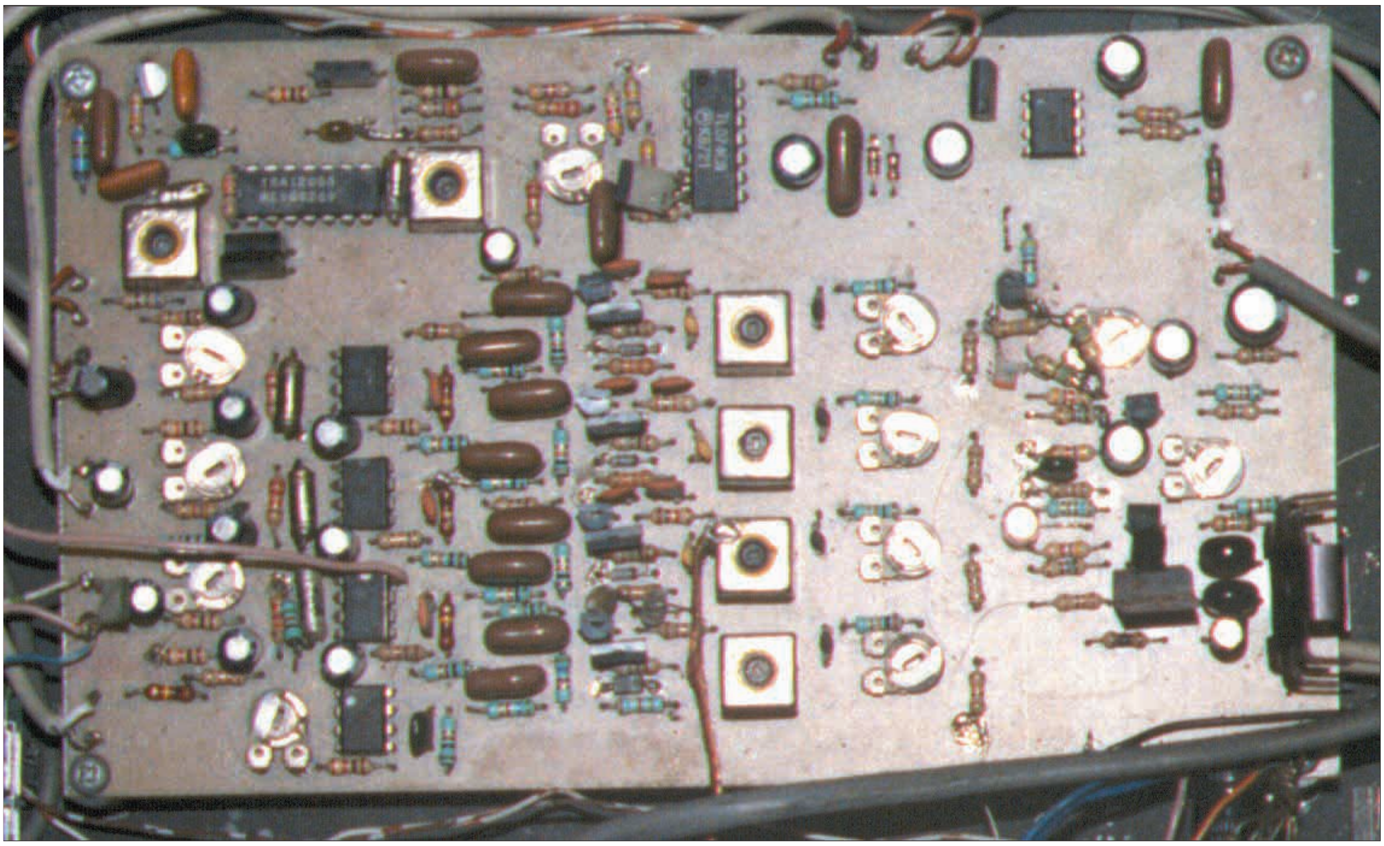
INITIAL CHECKS

ENSURE ALL components are of the correct value and, if polarity conscious, inserted the correct way round. Check the PCB thoroughly for shorted tracks and dry joints. A little care at this stage can prevent hours of head scratching and fault finding later. Apply the 15V power supply to the unit and check that the regulated supply is in fact 12V. **Table 1** gives typical voltages around the semiconductors for reference and fault finding. If all appears well, set RV1, RV2 and RV3 sliders to their mid positions, RV4, RV5, RV6, RV7 and RV8 sliders to the earthy end. Finally set RV10 to maximum resistance.

ALIGNMENT

CONNECT THE GUNN oscillator unit to the PCB. Low cost 50Ω coaxial cable such as RG58 is ideal for the purpose. A 56Ω resistor in series with a 10μF electrolytic capacitor should be fitted at the Gunn oscillator end of the cable to help prevent instability.

Because the link is full duplex, it will be necessary to set each side of the link to a specific centre frequency fairly accurately. In order to measure the frequency of the transmitter, the LNB's local oscillator frequency must first be calculated. The LNB



Completed printed circuit boad of the subsystem.

will of course still receive satellite transmissions from Astra at the upper end of the satellite receiver's IF passband. ZDF transmits on 10.963GHz for example. If the satellite receiver has to be tuned to 1663MHz to receive it then the local oscillator frequency will be 10963 - 1663 which equates to 9300MHz. It would thus follow that 10.3GHz would equate to 1000MHz and 10.5GHz to 1200MHz. The link that I have set up operates on 10.475 and 10.375GHz, with one transmitter operating horizontal polarisation and the other vertical. This helps to minimise any desensitisation.

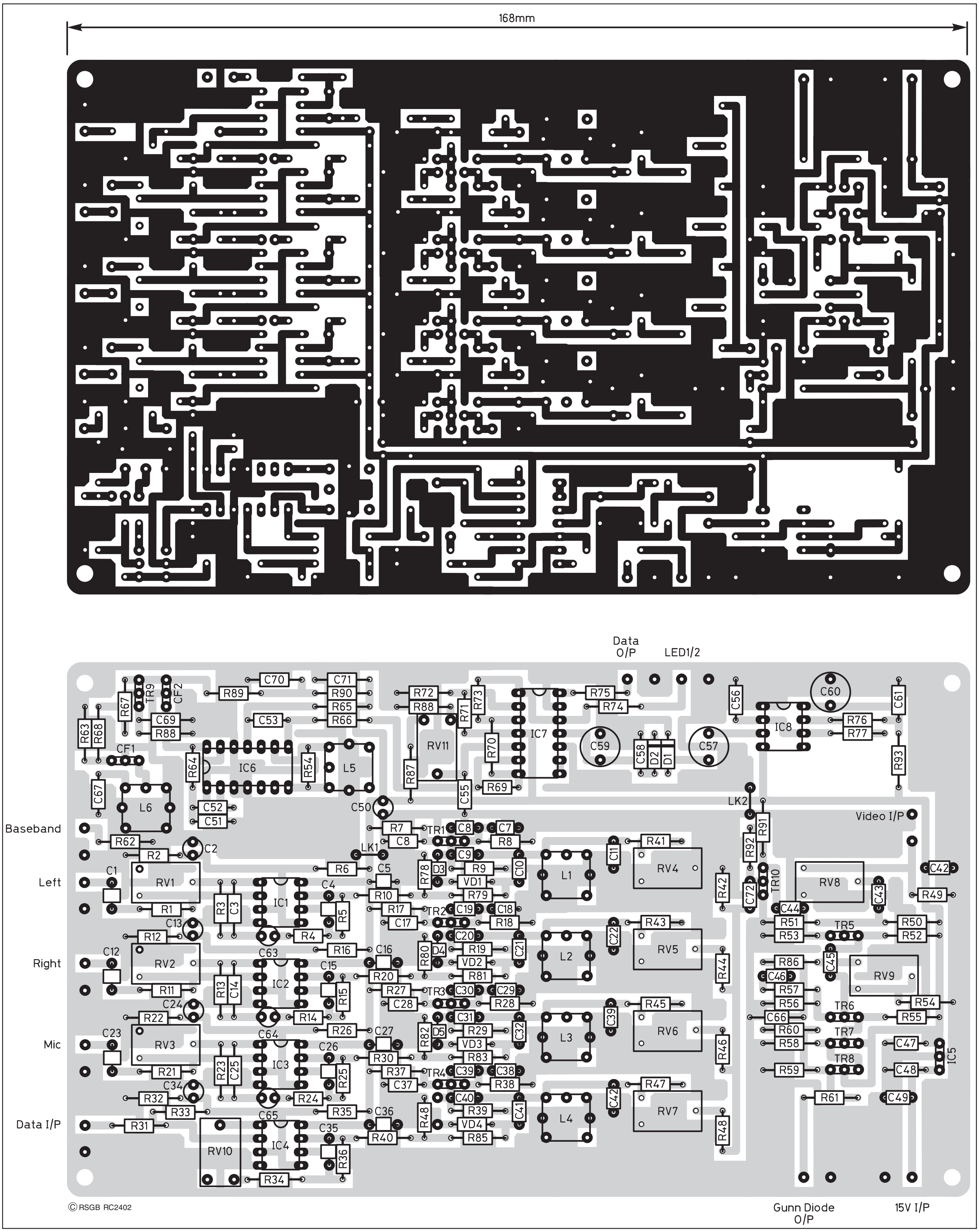


Fig 6: PCB foil pattern and component overlay.

Inside a converted 'Blue Cap' LNB. The glue which is added to 'pull' the local oscillator LF can be clearly seen in the botton right hand corner.

The satellite receiver should be set to the desired receive frequency and connected to a suitable monitor or TV. Apply 15V to the unit and connect a DC voltmeter between the Gunn output and ground. Adjust RV9 until a reading of 6.5V is obtained. Now adjust the tuning and matching screws on the Gunn cavity to give best power and a received signal on the satellite receiver. An indication of power can be estimated by measuring the current flowing through the mixer diode on the Gunn unit (if fitted). Alternatively, a separate cavity fitted with a microwave mixer diode placed a few inches away may be used.

Assuming all is well so far, apply a 1V peak-to-peak video signal to the video input. Rotating RV8 should produce a viewable picture on the monitor. If an oscilloscope is available, connect to the video output of the satellite receiver (suitably terminated with a 75Ω resistor or a video monitor) and adjust RV8 for 1V peak-to-peak as indicated on the oscilloscope. Alternatively, RV8 can be adjusted to give a picture similar in contrast to those received from Astra. If a staircase waveform is available then RV9 may be readjusted slightly for best linearity, readjusting RV8 as necessary to maintain a level of 1V peak-to-peak. Remove the video signal source.

Connect a frequency counter between the Gunn output and ground. Adjust RV4 to its mid position. With the aid of a plastic trimming tool, adjust L1 until a reading of 7.02MHz is obtained. Set the satellite receiver's audio to 7.02 MHz and apply a 1kHz sine wave to the left audio input, set the output to 775mV RMS and adjust RV1 for the loudest signal consistent with low distortion. If a deviation meter is available, adjust RV1 for 30kHz deviation. Reset RV4 to the earthy position. Adjust RV5 to its mid position. With the aid of a plastic trimming tool, adjust L2 until a reading of 7.20MHz is obtained. Set the satellite receiver's audio to 7.20MHz and apply a 1kHz sine wave to the right audio input, set the output to 775mV RMS and adjust RV2 for the loudest signal consistent with low distortion. If a deviation meter is available, adjust RV2 for 30kHz deviation. Reset RV5 to the earthy position.

Adjust RV6 to its mid position. With the aid of a plastic trimming tool, adjust L1 until a reading of 6.50MHz is obtained. Set the satellite receiver's audio to 6.50MHz

G6KSN's antenna-festooned balcony.

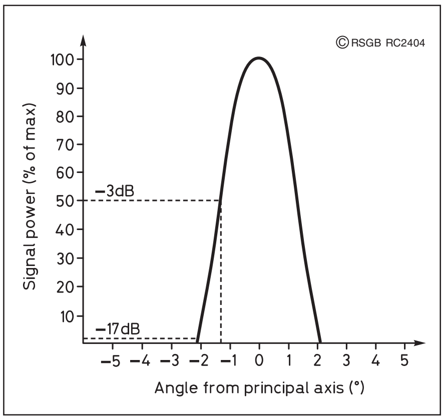


Fig 7: Graph of signal power received by a 60cm dish against deviation from the principal axis.

and apply a 1kHz sine wave to the microphone input, set the output to 1mV RMS and adjust RV3 for loudest signal consistent with low distortion. If a deviation meter is available, adjust RV3 for 50kHz deviation. Reset RV6 to the earthy position.

Disconnect the power from the board. Disconnect one end of R34 and reapply power to the board. Adjust RV7 to its mid position. With the aid of a plastic trimming tool, adjust L1 until a reading of 6.00MHz is obtained. Remove the power, reconnect R34 and connect a 10pF capacitor between the Gunn out and baseband in. Reapply power and connect an oscilloscope to the collector of TR9 via a x10 probe. Adjust the core of L6 for maximum observed signal at 6.00MHz. Transfer the probe to pin 8 of IC8 and apply a 20kHz square wave to the Data input, set the output to at least 10V peak-to-peak (but not more than 24V peak-to-peak). Adjust L5 for a symmetrical square wave signal, as seen on the oscilloscope. Decrease the resistance of RV10; an increase in amplitude of the displayed waveform should be noted. Continue to decrease resistance until no further increase in amplitude is noted. Re-adjust L5 for best amplitude and symmetry and then *increase* the resistance of RV10 until the waveform is 75% of the maximum amplitude as seen previously. Power down and disconnect one end of R34. Re-apply power and rotate RV11 from one end to the other and back again noting the 2 points at which LEDs 1 and 2 change over. Set RV11 mid way point between these two points. Remove the power, reconnect R34 and transfer the oscilloscope probe to the data out terminal. Re-apply power. A 20kHz square wave of at least 15V peak-to-peak should be observed. Both LEDs should be illuminated at half brightness at this time. Remove the capacitor between Gunn out and Baseband in.

Monitor each subcarrier in turn on the satellite receiver and adjust RV4

(7.02MHz), RV5 (7.20MHz), RV6 (6.00MHz) and RV7 (6.50MHz) for good signal-to-noise ratio on each subcarrier. This will vary, depending on overall system carrier-to-noise ratio as seen by the satellite receiver and should be done by adjusting the position of the LNB so that all 'sparklies' on the monitor are only just banished (ie at the P5 threshold) and only a blank raster remains on the monitor or TV set. Around 60dB should be obtained on the 6 and 6.5MHz carriers, around 50dB on the secondary carriers, although most receivers use a 2 to 1 compander circuit similar to DBX called 'Panda 1'. This system tends to mask the noise on these, and so may actually appear to be better than the main carriers.

TR1, 2, 3, 4 drain	10.8V
TR1, 2, 3, 4 source	4.3V
TR1, 2, 3, 4 gate	0.0V
TR5 collector	9.1V
TR5 base.	3.2V
TR5 emitter	2.5V
TR6 collector	8.9V
TR6 base	1.5V
TR6 emitter	0.9V
TR7 collector	12.0V
TR7 base	8.9V
TR7 emitter	8.2V
TR8 collector	12.0V
TR8 base	8.2V
TR8 emitter	7.6V
TR9 collector	7.0V
TR9 base	2.0V
TR9 emitter	1.4V
TR10 collector	9.4V
TR10 base	0.7V
TR10 emitter	0.0V
IC1, 2, 3, 4 pin 1, 2, 3	6.0V
IC1, 2, 3, 4 pin 4	0.0V
IC1, 2, 3, 4 pin 5, 6, 7	6.0V
IC1, 2, 3, 4 pin 8	12.0V
IC5 input	15-20V
IC5 ground	0.0V
IC5 output	12.0V
IC6 pin 1, 3, 4, 12	0.0V
IC6 pin 2	2.1V
IC6 pin 8	5.3V
IC6 pin 11	8.9V
IC6 pin 13	2.1V
IC6 pin 14	2.1V
IC7 pin 2	6.0V
IC7 pin 4	12.0V
IC7 pin 5	5.9V
IC7 pin 6	5.8V
IC7 pin 11	-9.0V
IC8 pin 1	0.0V
IC8 pin 2, 6, 7	5.8V
IC8 pin 3	5.7V
IC8 pin 4, 8	12.0V

Table 1: Typical circuit voltages.

SETTING UP THE LINK

THIS CAN PROVE quite difficult, especially if the path is a long one. To receive an adequate signal level the dishes at each end of the link need to be aligned to within about 1° in both the horizontal and vertical plane, as is illustrated in **Fig 7**. It may be useful to try setting the receive dish elevation by receiving a known terrestrial signal. Fortunately there are literally thousands of microwave transmitters operating between 10.5 and 10.7GHz across the UK. These take the form of Radar Doppler modules located on traffic lights. I can receive a number of these transmissions from this QTH and find them very useful indeed. The dish needs to have the elevation reduced by almost 30° compared with Astra, and if a standard offset dish is used it may be necessary to re-drill the bottom bracket so that it can be secured in this new position. The dish will appear to be pointing at the floor and the boom which supports the LNB will be about 10° below horizontal. It will be possible to align the elevation of the transmit dish by momentarily mounting the receive LNB on it and aligning on a traffic light or other known terrestrial source.

With the dishes roughly in alignment in the vertical plane, arrange for the remote station to radiate a carrier. It is easiest if the transmitting station leaves his dish stationary while the receive dish is adjusted. If no signal is detectable then the transmitting dish can be adjusted slightly and the process repeated. Once a signal is acquired, both azimuth and elevation of both dishes can be adjusted for maximum signal. Many satellite receivers have an AGC output for this purpose. A satellite alignment meter may also be used.

Once one side of the link is set up, the whole process can be repeated for the return path. If the link is only a few kilometres it may be possible to dispense with the receive dishes altogether. I can receive at least two radio amateurs from this QTH with just an LNB pointing out of the living room window! Small horn antennas may also be considered as a viable alternative if the path is true 'line of sight' and not more than, say, 15 or 20km.

DATA PORT CONFIGURATION

AS I SAID previously, the data port will work well at least up to 28800 baud (and possibly much higher). If you have a 486 or better machine and 16550 UART chips on the I/O card then try 38400 or 57600 baud. You will soon see when things are getting tricky, as the data rate will decrease or collapse altogether if either the PC or microwave link cannot handle it. On a P75 using Hyperaccess or HyperTerminal the data port will work at 57600 without any problems, but the data deviation and data slicer settings become more critical. 6MHz ceramic filters tend to be quite narrow and I have tried (without success) to find a source of wider ones. With 280 or 330kHz filters, the data port should be capable of 115200 baud. If anyone knows of a source of wide band filters for 6MHz, please let me know. I have been doing some tests with 10.7MHz filters and upconverting the 6MHz data signal by mixing it with a 16.7MHz local oscillator. Currently this seems to be the only way to go, but the 6MHz wideband option has more appeal.

For packet radio data transfer, I use G8BPQ's 408a packet switch software used in conjunction with G6AMU's Easyterm version 1.03g. At 28800 baud the data transfer rate on an old 386SX33 with a very ordinary I/O card exceeds 2000 characters per second. Tests with a 486 and even a Pentium do not yield significant increases in speed, and data rates above 28800 baud just don't seem to work. I put this down to limitations of the software, which was not really designed to work much beyond 9k6.

Table 2 shows an example of how to configure BPQ408a to work with the microwave link.

FINALLY

IN CONCLUSION I would like to say a word of thanks to Martin, G7RTQ. Martin is at the other end of the 3cm link and has been remarkably patient when tests have had to be carried out. Without his support and encouragement this unit would have never reached its current level of refinement. ♦

```
PORT
    ID=19200Bd link to WARLEY
    TYPE=ASYNC
    PROTOCOL=KISS
    IOADDR=3F8H
    INTLEVEL=4
    SPEED=19200
    CHANNEL=A
    QUALITY=10
    MAXFRAME=7
    TXDELAY=1
    SLOTTIME=1
    PERSIST=255
    FULLDUP=1
    FRACK=700
    RESPTIME=2
    RETRIES=25
    PACLEN=255
    MHEARD=N
    KISSOPTIONS=CHECKSUM
ENDPORT
```

Table 2: How to configure BPQ408a to work with the microwave link.